AIR CONDITIONING SYSTEM FOR A VEHICLE

Background of the Invention

Filed of the Invention

[0001] The invention relates to an air conditioning system for a vehicle having a refrigerant circuit which comprises a compressor, a condenser, an expansion valve and a latent cold storage the heat of which can be drawn by means of the refrigerant circuit. This drawing of heat is referred to as charging. Furthermore, the air conditioning system comprises means for cooling air, which is formed such that heat is drawn from the air and the heat is supplied to the latent cold storage. This supply of heat is referred to as discharging. In particular, such an air conditioning system is used for motor trucks, and is used there as a stationary air conditioning system.

Description of Related Art

[0002] A stationary air conditioning system for a vehicle is known from German Patent DE 198 52 641 C1, having a refrigerant circuit with a compressor, a liquefier, an accumulator and at least one ice storage unit. The ice accumulator unit is comprised of a vaporizer with an expansion organ and an ice accumulator surrounding the latter. Furthermore, a further vaporizer with an expansion organ is connected in parallel to the at least one ice accumulator unit, wherein it can be controlled by means of respective switching valves, if the refrigerant flows through the further vaporizer or the vaporizer of the ice accumulator unit. The compressor is mechanically driven by a driving motor of the vehicle and can be coupled with the latter by means of a magnetic clutch via a fan belt.

Summary of the Invention

[0003] It is the object of the invention to provide a compact air conditioning system which is adapted to cool a vehicle in a stationary operation of the vehicle.

[0004] The invention is characterized by an air conditioning system for a vehicle having a first refrigerant circuit which comprises an electrically driven compressor, a condenser, an expansion valve and a latent cold storage the heat of which is drawn by means

of the refrigerant circuit, and having means for cooling air which is formed such that heat is drawn from the air and the heat is supplied to the latent cold storage. By means of the electrically driven compressor, the power of the compressor can be adjusted independently of the rotational speed of a driving shaft of the vehicle and, if necessary, the compressor can also be provided with electrical energy independently of the drive of the vehicle. Thereby, a predetermined amount of heat can be drawn from the latent cold storage in a simple manner also during extreme hotness.

[0005] If a further primary air conditioning system is disposed in the vehicle, the compressor of which is driven by the driving shaft of the vehicle, for example, by the crank shaft, the charging of the latent cold storage of the air conditioning system can also be affected quickly when the compressor of the primary air conditioning system is operated at its maximal capacity.

[0006] The latent cold storage is characterized by a very high specific cold capacity. This has the advantage that the air conditioning system can be formed very compact. In particular, it can draw a high amount of heat from the air in the stationary operation of the vehicle when the driving shaft does not rotate.

[0007] In an advantageous formation of the invention, the air conditioning system hast a refrigerant circuit which comprises a pump, the latent cold storage and a heat exchanger by means of which heat is drawn from the air and the heat is then supplied to the latent cold storage. This has the advantage that the heat exchanger can be disposed at any position in the vehicle.

[0008] In a further advantageous formation of the invention, a blower is assigned to the heat exchanger which influences the air flow through the heat exchanger and simultaneously influences the air flow through a heating element. This has the advantage that only one blower is necessary for cooling the air, on the one hand, and for heating the air, on the other hand.

[0009] In particular, it is advantageous when the heating element is a heating heat exchanger through which a fluid flows which can be heated by means of a fuel heating device. With a heating element formed in such a manner a notably high heating power is possible.

[0010] In a further advantageous formation of the invention, the latent cold storage is disposed such that the air to be cooled flows through the latent cold storage and, at the same time, is cooled by the latter. Thus, the air conditioning system can be formed notably compact. In this context, it is notably advantageous when the refrigerant circuit comprises a plurality of latent cold storages. Accordingly, cooling at many positions of the vehicle can be affected. In particular, this is advantageous in motor trucks which have, besides a driver compartment, a sleeping/living compartment formed separately of the latter.

[0011] In a further advantageous formation of the invention, a generator is assigned to the air conditioning system which is driven by a driving shaft of a drive of the combustion engine, and thus, provides the electrical energy of the electrically driven compressor. In such a manner, the electrical driven compressor can be operated with high power during the driving operation.

[0012] Embodiments of the invention are described in greater detail below in conjunction with the accompanying drawings.

Brief Description of the Drawings

[0013] Figure 1 shows a first embodiment of the air conditioning system,

[0014] Figure 2 shows a second embodiment of the air conditioning system,

[0015] Figure 3 shows a third embodiment of the air conditioning system,

[0016] Figure 4 shows a fourth embodiment of the air conditioning system,

[0017] Figure 5 shows a fifth embodiment of the air conditioning system, and

[0018] Figure 6 shows a sixth embodiment of the air conditioning system.

Detailed Description of the Invention

[0019] Elements of the same construction and function are identified with the same reference numerals in all figures of the drawings.

[0020] An air conditioning system (Figure 1) is disposed in a vehicle, in particular, in a motor truck. The air conditioning system has a refrigerant circuit 1 which comprises an electrically driven compressor 2, a condenser 4 which has assigned a condenser blower 6 thereto, an accumulator 8, an expansion valve 10 and a latent cold storage 12.

[0021] The expansion valve 10 can be controlled or can merely be formed as a flow restrictor. The output of the compressor 2 is connected to the condenser 4 via a first line 14 and the output of the condenser 4, in turn, is connected to the accumulator 8 via a second line 16 which, preferably, also comprises a drier. The accumulator 8 is connected with the expansion valve 10 via a third line 18, and the output of the expansion valve 10 is connected to the latent cold storage via a fourth line 20. The output of the latent cold storage 12 is connected to the intake of the compressor 2 via a fifth line 22. The electrically driven compressor 2 is, preferably, supplied with electrical energy from a generator 24 which is driven by a driving shaft 26 of a drive 28 of the vehicle. For example, the drive 28 can be a combustion engine. However, the electrically driven compressor 2 can also be supplied with electrical energy in another way, for example, by means of a fuel cell or any elements outputting electrical energy, for example, a battery. Also, the electrically driven compressor 2 can be supplied with electrical energy by any combination of the elements mentioned above. By a respective dimensioning of these elements, the electrically driven compressor 2 can be operated with a power which is sufficient also under extreme operating conditions in order to draw the desired amount of heat from the latent cold storage 12.

[0022] During the operation of the electrically driven compressor 2, the refrigerant which can be, for example, R134a or also CO_2, is compressed, whereby its temperature increases. The condenser 4 is formed in cooperation with the condenser blower 6 such that heat is drawn from the refrigerant by the air flowing through the condenser 4.

[0023] The thus cooled and liquefied refrigerant flows further to the accumulator 8 via the second line 16, and then, to the expansion valve 10 via the third line 18 by means of which it is expanded to a lower pressure, wherein the temperature of the refrigerant decreases significantly. Subsequently, the refrigerant flows to the latent cold storage 12, and there, draws heat from the cold storage medium by vaporizing it. The refrigerant which is then gaseous again flows further to the electrically driven compressor 2 via the fifth line 22 and, there, is compressed again.

[0024] The high specific cold capacity of the latent cold storage 12 results from the fact that the cold storage medium in the latent cold storage draws energy by means of the refrigerant such that a phase transition from a liquid state to a solid state occurs. Thus, the latent cold storage can be compact. Furthermore, it can be produced inexpensively.

[0025] When the refrigerant is CO_2, it is preferred that the condenser 4 is a gas cooler and the lines 18, 22 contact each other in a internal heat exchanger and the accumulator is disposed in the line 22.

[0026] The air conditioning system comprises a refrigerant circuit 30 which has a heat exchanger 32, a pump 34 and a latent cold storage 12. The latent cold storage 12 is connected to the heat exchanger 32 via a sixth line 36, the output of which is connected with the intake of the pump 34 via a seventh line 38. The output of the pump 34 is connected with to the latent cold storage 12 via an eighth line 40.

[0027] Preferably, the pump 34 is electrically driven and, for example, can obtain the electrical energy necessary for it from a battery not shown. The pump 34 pumps the refrigerant of the refrigerant circuit through the latent cold storage 12, wherein the latent cold storage 12 is supplied with heat and is cooled in this manner. The cooled refrigerant then pours or flows to the heat exchanger 32 through the sixth line 36 which is supplied with air by a blower 42 in a controlled manner which then delivers the heat to the heat exchanger 32, and thus, is cooled and contributes to the desired cooling of the internal space of the vehicle. The heat exchanger 32 can be disposed in the region of the passenger compartment or can also be disposed in a sleeping or living room of the vehicle. The heat delivered from the flowing air heats the refrigerant in the heat exchanger 32, and thus, the heated refrigerant flows to the pump 34 via the seventh line 38 where it is pumped again to the latent cold storage 12.

[0028] It is preferred that the electrically driven compressor 2 is operated during the driving operation of the vehicle, and thus, heat is drawn from the latent cold storage 12. During the stationary operation of the vehicle, it is preferred that the compressor 22 is not operated, or at the most, is operated with a low electrical power. In the stationary operation, the pump 34 is driven dependent on the required cooling power, and accordingly, air is cooled in the vehicle by means of the refrigerant circuit 30.

[0029] In a second embodiment of the invention (Figure 2), in addition a heating element is provided which is a heating heat exchanger 44, wherein fluid, preferably a water glycol mixture, is flowing through the latter which can be heated by means of a fuel heating device 46 and is supplied to the heating heat exchanger 44 via a ninth line 48. The heating heat exchanger 44 is disposed such that the blower 44 also controls the air flowing through

the heating heat exchanger 44. Thus, simply with one blower 44, the air flowing through both the heating heat exchanger 44 and the air flowing through the heat exchanger 32 can be controlled.

[0030] In a third embodiment of the air conditioning system (Figure 3), an air heating element 50 is provided which, for example, can be formed as a PTC-resistance element, and thus, transforms electrical energy to heat and which is disposed such that the amount of air which flows next to the air heating element 50 is controlled by means of the blower 42. For example, the air heating element 50 can be formed as fuel air heating device.

[0031] In a fourth embodiment of the air conditioning system (Figure 4), the blower 42 is assigned to the latent cold storage 12 and the air to be cooled flows through the latent cold storage or flows next to cooling fins which are assigned to the latter and, thus, delivers heat to the latent cold storage 12 and is thus cooled. In this way, the air conditioning system can be formed notably compact, since the refrigerant circuit 30 can be omitted, in particular when at the plurality of positions of the vehicle, a cooling of the air has to be affected, it is advantageous in this context when the air conditioning system comprises a plurality of latent cold storages 12. This plurality of latent cold storages 12 can then be disposed at respective positions of the vehicle, for example the latent cold storage 12 in a motor truck can be disposed in the passenger compartment and the further latent cold storage 12 can be disposed in a sleeping and/or living room which is separately formed from the latter.

[0032] In the fourth embodiment of the air conditioning system, the fuel heating device 46 and the heating heat exchanger 44 or the air heating element 50 according to the embodiments of Figures 2 & 3 can also exist.

[0033] In a fifth embodiment of the air conditioning system (Figure 5), the fuel heating device 46 is disposed in a bypass 48 of the refrigerant circuit 30. In a sixth embodiment of the air conditioning system, the fuel heating device 46 is coupled to the sixth line 36.